IDENTIFICACION DE ELEMENTOS QUIMICOS EN HD 3473

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Resumen: Se estudia el espectro de la estrella HD 3473 y se identifican los elementos químicos presentes en dos placas Coudé de 16.9 Å/mm de dispersión. Se encuentra Fe en los tres estados de ionización, Si II y Mg II con anómala sobreabundancia, como así también se identifican satisfactoriamente N II, O II, Si III, Cl II, Ca II, Sc II, Ti II, Cr II, Mn II, Ni II, Sr II, Zr II y algunas tierras raras. Se comparan los resultados con los de algunas estrellas B normales y otros objetos anómalos.

I. INTRODUCTION

HD 3473 was found to be peculiar object by Bidelman (1966) who classified it as A2p-Si-Mg. Cowley (1965), using spectrograms of 125 Å/mm identifies strong lines at λ 4128 and λ4130 de Si II and λ 4481 of Mg II, and also, many other high excitation lines of both elements.

Naftilan (1977) performed a detailed model atmosphere analysis using three coudé spectrograms, two in the blue

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(dispersion of 15 Å/mm and 33 Å/mm) and one in the red (dispersion of 16 Å/mm). He obtained the following atmospheric parameters: T_{eff} = 9750°K, log g = 3.4. This value of the temperature is acord with the abscense of certain elements, as Si III, Fe III, He I, C II, but not with the extreme weakness of the neutral metal lines. He also observed the presence of emission fill-in in the cores of the stronger Si II and Mg II lines.

H. Levato obtained two spectrograms of HD 3473 using the coudé system at Kitt Peak 2.10m telescope which cover the normal photographic region. They have a linear dispersion of 16.9 Å/mm and are calibrated using the device described by Furenlid (1971). Using this observational material Z. López-García (1981) published a new description of the spectrum, confirming the presence of emission fill-in in the cores of the stronger lines and the absence of neutral metals. But certain elements, as Si III and Fe III, proper of hotter stars, are identified satisfactorely. Using a comparison of H_γ profiles generated with BALMER program of Peterson (1969) which uses ESW broadening theory, a determination of the atmospheric parameters gave the following results: T_{eff} = 11500°K log g = 3.4.

In view of the discrepances in the parameters determined in both papers and in the existence of double - ionized elements, a detailed identification of the complete spectrum of HD 3473 was then undertaken using the observational material taken by Levato. An abundance analysis using fully line blanketed model atmospheres is been performed and will be published soon.

II. IDENTIFICATION OF ATOMIC SPECIES

In Table I we have listed the wavelength measurements (λ) for HD 3473, the intensity (I) and the proposed

Table I

LINE IDENTIFICATIONS

λ obs	Int	λ lab	Ident	Mult.	λ obs	Int	λ lab	Ident	Mult.
3701.	4	01.39	Mn II	-			78.37	Fe II	192
3701.		01.90	Cr II	166	3779.65	2/3	79.58	Fe II	23
3703.			unid.		3780.42	1		unid.	
3703.	4	03.85	H 16		3781.60	1	81.51	Fe II	130
3704.	3/4	05.00	He I	25	3781.60	1	81.62	Ce II	-
		05.14	He I	25	3782.49	2/3	82.30	Y II	61
3708.	3/4		unid.		3783.49	4	83.35	Fe II	14
3709.66	4/5	09.29	Ce II	-			83.74	Cr II	-
		09.93	Ce II	-	3787.32	3	87.24	V II	100
3711.		11.97	H 15				86.94	Fe III	71
3714.	3/4	15.27	Mn II	-	3787.90	3		unid.	
3715.87	5	16.36	Ce II	-	3788.88	2	88.75	Ce II	-
3719.		19.48	Mn II	-			88.91	Fe III	102
3720.		19.94	Fe I	5			88.70	Y II	7
3721.89		21.94	H 14		3 [illegible].94	1	90.83	La II	-
3727.	3/4	27.04	Fe II	192	3791.48	3	91.41	Si III	5
		27.33	O II	3	3792.61	1/2	92.33	Ce II	-
		27.37	Cr II	117	3793.63	3	93.53	P II	-
3728.5	2/3	28.42	Ce II	-	3794.44	3	94.48	O II	34
		28.74	P II	-	3795.28	3	95.36	Si II	7.08
3729.	1/2		unid.		3795.61	3	95.55	Si II	7.08
3731.	1/3	31.26	Zr II	112	3796.28	3	96.11	Fe II	23
		31.26	Sm II	-			96.11	Si II	5
3732.		32.76	V II	15	3797.90	7	97.90	H 1	
3733.			unid.		3799.63	3	99.81	Ti II:	13
3734.		34.37	H 13		3800.95	3	01.21	Cr II	-
3736.		35.98	Sm II	-	3802.16	3		unid.	
3737.	3/4	37.13	Fe I	5	3806.15	2	06.54	Si III:	5
3740.	1/2	39.92	O II	21	3806.82	3	06.82	Fe II	153
3741.	2	41.56	Fe II	15	3807.34	2/3		unid.	
		41.63	Ti II	72	3809.52	2	09.46	Cl II	-
3743.44	2/3	43.36	Fe I	21	3813.90	9	14.00	Cr II	-
3743.44	2/3	43.39	Mn II	-			14.12	Fe II	153
		43.40	Fe III	-	3814.70	4	14.58	Ti II	12
3744.48	2/3	44.40	P II	-	3815.54	2	15.38	V II	166
3745.77	3/4	45.81	V II	15	3818.22	1/2	18.34	Y II	7
		45.90	Fe I	5	3819.88	1	19.67	Eu II	1
		45.97	Zr II	112	3821.40	1/2	21.68	O II	34
3746.32	3		unid.		3822.56	1		unid.	
3750.12	4	50.15	H 12		3824.57	4	24.44	Fe I	4
3751.23	2		unid.				24.91	Fe II	29
3753.62	2		unid.		3827.98	2/3	27.82	Fe I	45
3754.85	5/6	54.59	Cr II	20	3829.12	3	29.35	Mg I	3
3756.64	2	56.41	Sm II	-	3829.88	3/4	29.80	N II	30
3757.75	4	57.68	Ti II	72	3832.47	4	32.30	Mg I	3
3759.40	4	59.29	Ti II	13	3834.96	5	35.38	H 9	
		59.46	Fe II	154	3841.01	2/3	41.05	Fe I	45
3761.45	4	61.32	Ti II	13	3843.02	2/3		unid.	
3763.82	4	63.76	Mn II	-	3843.72	3/4		unid.	
		63.79	Fe I	21	3844.50	4	44.17	Mn II	-
3764.77	2		unid.		3846.40	3	46.31	Fe II	128
3756.45	2	65.62	Cr II	20			46.51	C II	33.02
3766.42	3	66.65	Cr II	20	3848.26	4	48.24	Mg II	5
3767.87	3/4	67.51	Cl II	-	3849.70	3	49.58	Ni II	11
3768.26	3		unid.				49.97	Fe I :	20
3770.60	2	60.63	H 11		3850.74	3	50.97	Cl II	-
3772.64	4		unid.		3851.41	1	51.38	Cl II	-
3774.26	3/4	74.33	Y II	7			51.65	Cl II	-
3775.75	4	76.06	Ti II	72	3852.26	1/2		unid.	
3778.40	4	78.32	Mn II	-	3853.50	5	53.66	Si II	1

Table I (continued)

λ obs	Int	λ lab	Ident	Mult.
3856.48	6	56.02	Si II	1
3858.65	2		unid.	
3860.51	2	60.80	Cl II	-
3862.68	6	62.60	Si II	
3866.21	5	66.01	Cr II	130
		66.16	Al II	17
		66.54	Cr II	130
3867.30	1	67.48	He I	20
		67.63	He I	20
3871.93	3	71.78	Sm II	-
3873.87	2/3		unid.	
3875.50	1		unid.	
3876.62	2/3	76.06	C II	33
		76.19	C II	33
		76.41	C II	33
		76.53	C II	36
		76.66	C II	33
3878.20	4	78.02	Fe I	20
		78.03	C II	33
3878.98	4/5	79.00	Mn II	-
3879.60	2	79.64	C II	33
3881.68	3	81.92	Ni II	11
3882.50	2	82.45	O II	11
		82.45	Ce II	-
3883.40	3	83.78	Cl II	-
3884.54	3		unid.	
3885.90	4	86.28	Fe I	4
3889.05	8	89.05	H 8	
3889.44	3		unid.	
3892.12	3	92.15	Cr II	167
3892.79	3/4		unid.	
3894.30	3		unid.	
3896.50	3	96.30	O II	11
3897.00	3	96.80	Ce II	-
3898.18	3	98.07	Mn II	-
		98.12	Mg I	47
		98.27	Ce II	-
3900.70	3	00.55	Ti II	34
		00.68	Al II	1
3903.22	3	03.27	V II	11
3904.07	2		unid.	
3905.75	6	05.52	Si I	3
		05.64	Cr II	167
3907.30	3	07.10	Eu II	-
		07.29	Ce II	-
3907.90	3	08.03	Pr II	-
3909.10	2	09.25	Cr II	129
3911.88	1	11.96	O II	17
3914.36	3	14.48	Fe II	3
3917.20	2	17.32	Mn II	-
3918.40	3	18.28	Ce II	-
		18.51	Fe II	191
3919.10	2	18.98	C II	4
		19.00	Si II	21
		19.01	N II	17
		19.29	O II	17
3920.85	3	20.69	C II	4
3923.78	2		unid.	
3925.04		25.46	Pr II	-
3926.65	2	26.58	O II	11

λ obs	Int	λ lab	Ident	Mult.
3928.71	1	28.60	Cl II	-
3929.52	2	29.73	V II	10
3930.65	3	30.50	Eu II	5
3931.18	3	31.09	Ce II	-
		31.37	Ce II	-
3931.90	2	32.02	Ti II	34
3933.45	8	33.66	Ca II	1
3937.90	2		unid.	
3938.42	3	38.29	Fe II	3
3939.68	1		unid.	
3941.32	3	41.22	Mn II	-
		41.51	Nd II	-
3942.27	2	42.15	Ce II	-
3942.74	2	42.75	Ce II	-
3943.98	2	44.01	Al I	1
		44.19	C II	32
3945.36	3	45.00	C II	32
		45.05	O II	6
		45.20	C II	32
3947.00	3	47.08	C II	32
		47.72	C II	32
		47.72	C II	31
3948.38	2	48.33	C II	32
3950.24	2	50.36	Y II	6
3952.27	3	51.97	V II	10
		52.06	C II	32
		52.54	Ce II	-
3954.61	6	54.30	Si II	7.07
		54.51	Si II	7.07
		54.38	Fe III	120
3956.00	5	55.74	Si II	21
3957.20	3		unid.	
3957.82	4	57.66	Fe II	13
3958.45	2		unid.	
3959.22	2		unid.	
3959.72	3		unid.	
3961.24	3	61.52	Al I	
3961.88	4	61.63	Cl II	-
3962.56	4		unid.	
3963.34	3		unid.	
3964.75	3	64.82	Fr II	-
3965.70	3		unid.	
3966.94	3	67.05	Ce II	-
3968.47	1		unid.	
3970.04	8	70.07	He	
3973.68	3	73.64	V II	9
		73.76	C II	37.38
3975.84	3	75.34	C II	38
		75.75	C II	35
3976.68	3	76.88	Fe III	69
3979.00	3	78.76	C II	37
3979.56	3	79.42	Fe III	120
		79.52	Cr II	183
3981.70	3	81.61	Fe II	3
3982.18	3	82.06	Pr II	-
		82.59	Y II	6
3983.24	3	82.90	Ce II	-
3983.79	4	83.96	Hg II	-
3984.64	3	84.68	Ce II	-
3985.72	3/4		unid.	

Table I (continued)

λobs	Int	λlab	Ident	Mult.
3987.02	3		unid.	
3988.83	3		unid.	
3990.40	3	90.15	Cl II	-
3991.11	3	91.14	Zr II	30
3992.27	6/7	91.77	Si II	20
3993.92	2	93.82	Ce II	-
3995.20	3	95.00	N II	12
3995.72	3	95.73	Ti II	-
3996.16	3	95.86	Al II	47
		96.18	Al II	47
		96.36	Fe II	190
		96.38	Al II	47
3998.41	6	98.01	Si II	20
3999.41	2	99.24	Ce II	-
4000.64	2		unid.	
4002.20	3	02.07	Fe II	29
		02.48	Cr II	166
		02.55	Fe II	190
4002.80	4	03.33	Cr II	194
4004.35	2	05.07	V II	215
4005.66	3	05.71	V II	32
4007.48	1	07.55	Cr II	-
		07.72	Fe II	189
4008.62	1	08.71	Pr II	-
4012.55	4	12.25	Nd II	-
		12.38	Ce II	-
		12.39	Ti II	11
		12.47	Fe II	126
		12.50	Cr II	-
4013.32	4	13.80	Mg II	-
4015.50	3	15.20	Fe II	142
		15.50	Ni II	12
4016.68	4	16.22	Si II	19
4017.04	2	17.28	C II	27
4017.74	2/3	17.96	Cr II	166
4019.21	2	19.53	P II	-
4021.42	3	21.17	C II	27
4021.99	3	22.37	Cr II	183
4022.68	2	22.36	Fe III	45
4023.30	1	23.39	V II	32
4024.44	2	24.45	Zr II	54
		24.49	Ce II	-
		24.55	Fe II	127
4025.54	3	25.07	Fe III	53
4026.39	2	26.19	He I	18
		26.36	He I	18
4029.34	1/2	29.68	Zr II	41
4030.52	2/3	30.28	Cr II	19
		30.75	Si III	8.05
4031.13	2	31.34	Ce II	-
		31.46	Fe II	151
4032.54	2	32.95	Fe II	126
4035.06	2	35.09	N II	39
4036.75	2/3	37.04	V II	-
4037.59	3		unid.	
4038.27	2	38.03	Cr II	194
4039.24	2	39.12	Fe III	45
4039.24	2	39.30	Al II	62
		39.40	Al II	62
4040.48	2/3	40.76	Ce II	-

λ obs	Int	λ lab	Ident	Mult.
		40.48	Nd II	-
4042.32	1	42.58	Ce II	-
4043.52	1	43.54	N II	39
4045.35	2		unid.	
4046.20	4	45.82	Fe I	43
		46.34	Ce II	-
4072.22	1		unid.	
4048.68	2/3	48.68	Zr II	43
		48.82	Fe II	172
4049.06	3/4	48.83	Fe II	172
		49.14	Cr II	193
4050.12	3	50.32	Zr II	43
4051.25	2	51.08	Fe III	98
		51.21	Fe II	172
4053.78	2	53.59	Fe III	98
		53.81	Ti II	87
		53.81	Ce II	-
4054.67	2	54.86	Pr II	-
		54.99	Ce II	-
4055.63	2/3		unid.	
4057.00	5	56.99	Si II	7.18
4058.36	3		unid.	
4059.85	2		unid.	
4061.12	1	61.09	Nd II	-
4063.50	4	63.60	Fe I	43
4066.88	2/3	67.50	Ni II	11
		67.05	Cr II	193
4070.12	2/3	69.88	Fe II	188
		70.03	Fe II	22
4071.35	3	71.74	Fe I	43
4072.46	4	72.56	Cr II	26
		72.71	Si II	3.01
4073.77	1/2	73.80	Nd II	-
4075.66	4/5	75.45	Si II	3.01
		75.85	C II	36
		75.87	O II	10
		75.95	Fe II	21
4076.50	5/6	76.78	Si II	3.01
		76.87	Cr II	19
4077.48	6	77.50	Cr II	19
		77.62	C II	35.01
		77.71	Sr II	1
		77.78	C II	35.01
4079.00	3		unid.	
4081.17	2	81.19	Fe III	119
		81.22	Ce II	-
		81.42	Fe II	188
4082.46	2	82.30	Cr II	165
4083.12	2	83.23	Ce II	-
4085.48	3	85.23	Ce II	-
4087.02	3	87.16	O II	48
		87.27	Fe II	28
4089.54	2/3	89.49	Cr II	164
4090.22	2		unid.	
4091.66	1/2		unid.	
4092.67	2	92.94	O II	10
4093.44	2	93.55	Ce II	-
4094.04	2	94.18	O II	10
4095.53	2		unid.	
4096.42	2	96.54	O II	21

Table I (continued)

λ obs	Int	λ lab	Ident	Mult.
4098.09	3	98.27	O II	46
4101.70	9	01.73	H	
4104.52	3	04.74	O II	20
4105.68	3		unid.	
4106.48	2		unid.	
4110.56	4	10.52	Ce II	29
4113.92	3	13.82	O II	37
4114.83	2	14.90	Ce II	-
4116.12	1		unid.	
4118.14	3	18.35	Ce II	-
4119.18	3	19.22	O II	17
4125.70	2/3		unid.	
4128.42	7	28.07	Si II	3
4131.32	7	30.89	Si II	3
4135.66	2	35.77	Cr II	163
4136.56	3/4	36.94	Mn II	-
4137.84	3/4	37.93	Fe III	118
		38.21	Fe II	150
4139.68	3	39.37	Fe III	118
4140.54	2	40.51	Fe III	118
4141.55	3	41.21	Pr II	-
4142.95	3/4	43.07	Fe II	188
4143.58	3	43.87	Fe III	-
		43.87	Fe I	43
		43.76	He I	53
4145.10	2/3	45.00	Ce II	9
		45.10	S II	44
4145.60	3	45.74	Fe III	-
		45.77	Cr II	162
4146.06	4	46.23	Ce II	-
4146.94	3/4	47.04	Cl II	-
		47.26	Fe II	141
4149.14	2	49.22	Zr II	41
4150.72	2	50.97	Zr II	42
4151.32	2	51.00	Cr II	163
		51.46	N II	6
4151.99	2	51.97	Ce II	-
4153.17	1	52.98	Fe II	45
		53.10	S II	44
4154.18	2		unid.	
4155.36	1		unid.	
4157.55	1		unid.	
4158.80	1	58.45	Fe II	12
4160.52	4	60.28	Fe II	149
		60.56	P II	30
		60.62	Fe II	39
4161.42	5	61.80	Sr II	3
4164.43	2	64.19	Pr II	-
		64.79	Fe III	118
4167.54	3	67.26	Mg I	15
		67.27	Mg I	15
		67.69	Fe II	149
4169.84	1	69.98	Fe II	12
4171.20	2	*71.04	Mn II	40
		*71.51	Mn II	50
		*71.60	N II	43
4171.86	3	71.51	Mn II	-
		71.90	Ti II	105

λ obs	Int	λ lab	Ident	Mult.
		71.92	Cr II	18
4173.20	3	73.45	Fe II	27
4174.38	3	74.27	Fe III	-
		74.32	Mn II	-
4175.42	3		unid.	
4176.20	1	76.16	N II	42
		76.44	Fe II	149
4178.92	5	*78.48	P II	-
		78.86	Fe II	28
4180.94	2	80.97	Fe II	148
4181.74	2	81.50	Cr II	181
4182.79	2	82.69	Fe II	149
4183.97	3	84.09	Fe III	22
4185.80	3	85.45	O II	8
4187.02	6	87.14	Si II	7.17
4188.35	2		unid.	
4190.62	5	90.72	Si II	7.26
4191.40	3		unid.	
4193.74	2/3	93.14	Mg II	
4194.58	2		unid.	
4195.42	2	95.41	Cr II	161
4198.13	3	98.13	Si II	7.26
4198.78	3	98.72	Ce II	-
		99.09	Fe II	141
4201.12	6	00.66	Si II	7.06
		00.90	Si II	7.06
4202.82	4	02.94	Ce II	-
4205.50	4	05.05	Eu II	1
		*05.40	Mn II	2
		05.48	Fe II	22
4207.03	2	07.37	Cr II	26
		06.74	Pr II	-
4208.21	3		unid.	
4212.42	2		unid.	
4214.94	2		unid.	
4216.12	3/4	15.52	Sr II	1
4217.98	2	18.18	Ti II	33
4218.66	1		unid.	
4220.49	1	20.32	Fe III	-
4222.34	2	22.39	Fe III	-
4223.11	2/3	22.98	Pr II	-
4225.00	3/4	24.85	Cr II	162
4226.87	3/4	26.83	Al II	46
4228.20	1/2		unid.	
4229.30	1		unid.	
4230.39	2	30.32	P II	-
4232.77	4	32.86	Si II	7.01
4233.44	5/6	33.17	Fe II	27
		33.26	Cr II	31
4235.92	2/3	35.73	Y II	5
		35.94	Fe I	152
4236.58	2	36.93	N II	48
		37.05	N II	48
4237.64	3	37.57	Al II	23
4238.66	3	38.78	Fe III	104
		38.80	Mn II	-
4239.84	2/3	39.91	Ce II	-
4240.70	3/4	40.75	Al II	36
4242.57	4/5	*42.34	Mn II	100
		42.38	Cr II	31

Table 1 (continued)

λ obs	Int	λ lab	Ident	Mult.
		42.47	Mg II	
4244.82	2	44.63	P II	-
		44.80	Ni II	9
4246.84	4	46.82	Sc II	7
4248.59	2/3	48.68	Ce II	-
4249.94	2/3	49.95	Fe III	-
4250.59	3	50.13	Fe I	152
4251.24	3	51.11	Ga II	-
		51.16	Ga II	-
4262.64	3	52.62	Cr II	31
4253.40	3	53.38	Cl II	-
4254.54	1	54.35	Cr I	1
4255.70	2	55.64	Ga II	-
		55.70	Ga II	-
		55.74	Ga II	-
4258.34	4/5	58.16	Fe II	28
		*58.35	Fe II	21
4260.02	3		unid.	
4261.40	4		unid.	
4261.87	3/4	61.92	Cr II	31
4264.40	1/2		unid.	
4266.08	1	66.23	Cr II	-
4266.75	1/2	66.88	Fe III	-
4269.12	3	69.29	Cr II	31
4270.28	2/3	70.39	Fe II	125
4271.46	3	71.15	Fe I	152
4273.83	2/3	73.42	Fe III	121
4275.70	1/2	75.57	Cr II	31
4277.42	1		unid.	
4278.22	3	78.10	Cr II	161
		78.13	Fe II	32
4278.81	2/3		unid.	
4282.22	3	82.47	Mn II	-
4284.25	3	84.21	Cr II	31
		*84.42	Mn II	6
4285.60	2		unid.	
4286.44	2	86.13	Fe III	121
		86.13	Fe II	-
4287.78	3	87.89	Ti II	20
4288.79	3	88.60	P II	-
4289.74	3/4	89.94	Ce II	-
4290.59	4	90.22	Ti II	41
4292.35	2/3	92.24	Mn II	-
4292.98	2		unid.	
4294.34	3/4	94.10	Ti II	20
4295.34	3		unid.	
4296.36	3	96.57	Fe II	-
4297.42	1/2	97.62	C II	41
		97.76	Pr II	-
4299.78	4	00.05	Ti II	41
4300.46	3	00.33	Ce II	-
4303.02	4/5	03.17	Fe II	27
4304.08	3	03.82	O II	54
4304.78	2/3	04.81	Fe III	121
4305.84	3	05.45	Sr II	3
		05.76	Pr II	-
4307.12	2		unid.	
4308.00	4/5	07.90	Ti II	41
		*07.91	Fe I	42
		08.16	Mn II	-

λ obs	Int	λ lab	Ident	Mult.
4310.32	1	10.37	Fe III	121
4311.70	2		unid.	
4313.22	3	13.03	Ti II	220
		13.10	C II	28
4314.36	3/4	14.08	Sc II	15
		14.29	Fe II	32
4315.06	3	14.98	Ti II	41
4317.27	1/2	17.14	O II	2
		17.26	C II	28
		17.32	Zr II	40
4318.80	2	18.60	C II	28
		18.94	Sm II	-
4321.10	2/3	20.74	Sc II	15
		21.34	Fe II	220
4321.60	1/2	21.65	C II	28
4324.96	3/4	25.01	Sc II	15
		25.03	Mn II	-
4327.30	2	27.84	O II	41
4329.17	2	29.02	Sm II	-
4329.99	3	30.26	Ti II	94
4330.66	3	30.71	Ti II	41
4331.36	3/4	31.53	Fe II	-
4336.78	2	36.87	O II	2
4338.85	3	38.70	Fe II	32
4340.62	9	40.47	Hγ	
4341.96	3/4		unid.	
4342.65	3/4		unid.	
4343.94	4	43.98	Mn II	-
4346.16	2/3		unid.	
4347.85	4	47.80	Sm II	-
4350.15	2/3		unid.	
4351.64	4	51.76	Fe II	27
4353.91	3		unid.	
4354.44	3	54.36	Fe II	213
4355.08	2/3	55.03	Fe II	202
4356.09	2/3		unid.	
4358.11	2/3	58.17	Nd II	-
4358.82	2/3	58.73	Y II	5
		59.12	Fe II	202
4360.08	2/3	60.03	Fe II	148
4361.31	2	61.25	Fe II	-
4362.16	2/3	62.10	Ni II	9
4362.80	3/4	62.93	Cr II	179
4363.66	2/3		unid.	
4365.00	3	64.66	Ce II	-
		64.89	Fe II	202
		65.22	Mn II	-
4365.98	2	66.16	Fe II	216
4366.86	2	66.90	O II	2
4367.76	4	67.66	Ti II	104
4368.41	2/3	68.26	C II	45-46
		68.33	Pr II	-
4369.06	2/3	69.28	O II	26
4370.06	2	69.86	C II	45
4370.90	3	70.66	C II	46
4371.74	1/2	71.59	C II	45
4372.43	3	72.22	Fe II	33
		72.35	C II	46
		72.35	C II	45
		72.49	C II	45

Table I (continued)

λ obs	Int	λlab	Ident	Mult.
4373.60	3/4		unid.	
4374.44	3/4	74.27	C II	45
		74.46	Sc II	14
4375.12	2	75.01	C II	45
4377.14	5	76.96	Si II	7.16
4378.98	2		unid.	
4379.67	1/2	79.61	Mn II	-
4380.50	3		unid.	
4381.84	2	81.79	Fe II	9
4383.43	3	83.55	Fe I	41
4384.54	6	*84.33	Fe II	32
		84.64	Mg II	10
4385.71	2/3	85.38	Fe II	27
4386.90	1/2	86.86	Ti II	104
4387.91	2	87.93	He I	51
4388.70	1		unid.	
4390.63	4/5	90.58	Mg II	10
4393.64	1/2		unid.	
4394.64	3/4	95.03	Ti II	19
4395.66	2/3	95.78	Fe III	4
4396.50	2/3		unid.	
4399.38	2/3	99.76	Ti II	-
4400.76	3	00.36	Sc II	14
4403.06	1/2	02.88	Fe II	-
4403.74	2	03.51	Mn II	-
4406.10	1/2	05.85	Pr II	-
4408.96	3/4	08.84	Pr II	-
		09.16	C II	40
4410.14	1	09.98	C II	39
4410.81	2	11.16	C II	39
4414.18	3/4	14.28	P II	-
4415.86	3	15.56	Sc II	14
4416.38	4	16.82	Fe II	27
4417.74	3	17.72	Ti II	40
4418.90	3	18.78	Ce II	-
4419.92	3	19.59	Fe III	4
4421.10	1	20.71	P III	-
4423.28	1		unid.	
4424.12	1	24.07	P II	-
		24.34	Sm II	-
4427.32	1	27.21	N II	56
4427.99	2	28.00	Mg II	9
4430.74	3	30.95	Fe III	4
4433.86	4/5	33.99	Mg II	9
4435.06	3/4	35.58	Eu II	4
4436.31	5/6	36.48	Mg II	-
4439.48	1	39.13	Fe II	32
4442.20	3		unid.	
4443.72	3	43.80	Ti II	19
4444.46	2	44.39	Ce II	-
		44.56	Fe II	201
4446.22	3	46.25	Fe II	187
4447.03	2/3	47.03	N II	-
4448.20	2	48.21	O II	35
4448.88	2/3		unid.	
4449.82	2/3	49.66	Fe II	222
		49.86	Pr II	-
4451.41	2	51.55	Fe II	-
		51.57	Nd II	-
4453.94	1		unid.	

λ obs	Int	λlab	Ident	Mult.
4455.28	3	55.26	Fe II	-
4455.62	2/3	55.85	Fe II	140
4457.42	2		unid.	
4461.52	2	61.43	Fe II	26
4464.05	1/2		unid.	
4464.72	2	64.46	Ti II	40
4465.40	2	65.40	O II	94
4468.77	2	68.49	Ti II	31
4470.00	2		unid.	
4473.00	3	72.92	Fe II	37
4474.26	2/3	74.19	Fe II	171
4476.18	1		unid.	
4477.70	2	77.74	N II	21
4478.93	3	79.64	Mn II	-
4481.24	7	81.23	Mg II	4
4483.66	2	83.35	P II	-
		83.90	Ce II	-
4484.92	1/2	84.93	Fe II	9
4487.14	1	86.91	Ce II	-
4487.82	1/2	87.72	O II	104
4488.30	3	88.32	Ti II	115
4488.81	4	89.18	Fe II	37
4490.08	2		unid.	
4491.54	2/3	91.40	Fe II	37
4493.27	2	93.58	Fe II	222
4494.22	2		unid.	
4497.16	1/2	96.96	Zr II	40
4499.78	2		unid.	
4500.33	3	*00.32	Ti II	18
4501.47	2/3	01.27	Ti II	31
4504.84	2		unid.	
4506.84	1	*07.19	Cr II	16
		07.20	Fe II	213
4507.65	2/3	07.56	N II	21
4511.92	1/2	11.82	Cr II	191
4514.80	2/3		unid.	
4515.68	4	15.34	Fe II	37
4516.30	4	16.50	Cr II	191
4519.00	1/2	18.60	Mn II	-
4520.02	2/3	20.22	Fe II	37
4522.39	3	22.59	Eu II	4
		22.63	Fe II	38
4537.73	2		unid.	
4525.06	1/2	*25.21	Ti II	18
4525.75	3	25.75	Fe II	9
4528.45	2/3	28.51	V II	56
4529.10	3/4	29.46	Ti II	82
4529.80	2/3	29.56	Fe II	171
4543.20	4/5	*33.97	Ti II	50
		34.17	Fe II	37
		34.26	Mg II	-
4534.80	4/5		unid.	
4536.51	3	36.72	Cl II	-
4537.56	3		unid.	
4539.75	2	39.62	Cr II	39
		39.76	Ce II	-
4541.18	2/3	41.52	Fe II	38
4542.22	1/2		unid.	
4544.30	2	44.07	Ti II	-
4545.20	1/2	*45.14	Ti II	30

Table 1 (continued)

λ obs	Int	λ lab	Ident	Mult.
4545.98	3		unid.	
4546.64	2		unid.	
4550.05	4/5	49.47	Fe II	38
		49.62	Ti II	82
4551.38	1		unid.	
4553.10	3	52.62	Si III	2
4553.58	2		unid.	
4554.08	2	54.03	Ba II	1
4554.76	2/3	54.83	P II	-
		55.01	Cr II	-
4556.20	2	55.89	Fe II	37
4557.80	3	58.00	P II	-
4558.30	4	58.58	Fe II	20
4558.80	4	58.66	Cr II	44
4559.46	3/4	59.09	Fe III	-
4560.76	1/2	60.96	Ce II	-
4562.54	1/2		unid.	
4563.54	3	63.76	Ti II	50
4564.94	3		unid.	
4565.84	3	65.78	Cr II	39
4566.86	2/3		unid.	
4567.70	2	67.82	Si III	2
4569.93	2	69.82	Fe III	82
4570.44	1/2	70.34	Fe III	66
4571.68	3/4	71.97	Ti II	82
4573.14	2	73.14	Fe III	-
4575.00	2/3	74.16	Si III	2
4575.90	2/3	76.33	Fe II	38
4576.88	2/3		unid.	
4579.08	2		unid.	
4580.05	3	80.06	Fe II	26
4580.72	3	80.45	Ti II	-
4581.80	2	81.71	P II	-
		82.12	Fe II	19
4582.94	2/3	82.84	Fe II	37
4584.10	4/5	83.83	Fe II	38
4584.77	3/4	85.00	Cl II	-
4587.80	3/4		unid.	
4588.56	4	88.22	Cr II	-
4589.96	3/4	89.89	Cr II	44
		89.96	Ti II	50
4590.68	2	90.97	O II	15
4591.85	3/4	92.09	Cr II	44
4592.70	2/3		unid.	
4595.52	1	95.68	Fe II	38
4596.46	2/3	96.17	O II	15
4597.75	1		unid.	
4604.02	1		unid.	
4604.70	2/3		unid.	
4605.62	1/2		unid.	
4608.54	1		unid.	
4611.40	1		unid.	
4612.42	1/2		unid.	
4612.78	2		unid.	
4614.04	2/3	13.87	N II	5
4614.94	1		unid.	
4616.80	3/4	16.64	Cr II	44
		16.95	Fe III	108
4618.14	2		unid.	
4618.98	3	18.83	Cr II	44
4619.48	2		unid.	
4620.84	3/4	20.51	Fe II	38
4621.54	6	21.42	Si II	7.05
		21.72	Si II	7.05
4626.02	3	25.91	Fe II	186
4626.83	3	26.83	Fe III	108
		*26.61	P II	15
		*26.78	Fe II	170
4627.31	2	27.44	C II	50
4628.45	1/2	28.16	Ce II	-
4629.25	3	29.34	Fe II	37
4629.94	3	29.70	Al II	35
		29.98	C II	49

*

The identifications with * are tentative.

identifications. The later were done on intensity tracings of both spectrograms made with the PDS of Kitt Peak combined with wavelengths measurements made at the Grant machine of La Plata Observatory. The intensities are given in the scale published by Levato and Malaroda (1977). The sources for the line identifications are these given by Adelman and Snijders

(1974) and Adelman (1978). As the rotational velocity of HD 3473 is relatively high (75 km sec^{-1}) allowance has to be made for it when considering the interval for the coincidence of the observed wavelength and laboratory value.

A visual inspection of the profiles of the most intensity lines of both spectrograms show that the equivalent widths of them differ by almost 30%, but it is clear that aditional material is necessary to clarify this point.

All atomic species with ionization stages three or lower, for which line-list exist in the references given above were looked for. So the atomic species which do not appear in the summary given in Table II have not been found or the evidence of their presence is considered very weak. To be included in the final list of Table I a feature had to be present on both tracings. The identifications between parenthesis are tentative.

In Table II we have indicated the atomic species which we believe are definitely present and possibly present in the spectrum of HD 3473. An atomic specie has been considered as possibly present when very few lines were identified or the main features appeared blended. Let us make some comments about each particular species:

1. HI. H_{14} is the last Balmer line detected.
2. He I. Only λ4026 is identified.
3. C II. Multiplets 4 and 33 are present and also some weaker lines, but multiplet 6, with the most intense lines is not observed.
4. N II. Lines of intensities stronger than 6 are present.
5. O II. The strongest multiplets 2, 5, 6 and 10 are seen. Some weaker lines are present.

6. Mg I. All lines are blended.
7. Mg II. All the strongest lines are present. They are of unusual intensity.
8. Si II. Multiplets 1 and 3 are present with lines of a grat intensity. Other high excitation lines are also present.
9. Si III. Multiplet 2 is observed.
10. P II. Only some weak lines are identified.
11. Cl II. The strongest lines are present.
12. Ca II. H and K lines are present.
13. Sc II. The strongest lines of multiplets 7 and 15 are seen.
14. Ti II. The strongest lines of multiplets 13, 19, 20, 31, 34, 41 and 52 are present.
15. V II. Only the strongest lines are weakly present.
16. Cr II. Lines brighter than intensity 20 are present.
17. Mn II. The strongest lines are seen.
18. Fe I. The strongest lines of multiplets 4, 5, 20, 43 and 45 are seen.
19. Fe II. A lot of lines have been found.
20. Fe III. Many strong and intermediate lines are seen.
21. Co II. The strongest line λ 4160.69 is observed blended with Fe II.
22. Ni II. The strongest lines of multiplets 9, 10, 11 and 12 are present.
23. Y II. It is not satisfactorely identified.
24. Zr II. Strong and intermediate lines of multiplets 16, 30, 41 and 43 are identified.
25. Rare Earths. Numerous lines of Ce II, Pr II, Nd II, Sm II and Eu II are well identified.
26. Hg II. The presence of λ 3983.96 is confirmed.

Table II

ELEMENTS IN HD 3473

Definitely Present	H, NII, OII, MGII, SiII, SiIII, ClII, CaII, ScII, TiII, CrII, MnII, FeII, FeIII, NiII, SrII, ZrII, CeII, PrII, NdII and EuII.
Possibly present	HeI, CII, AlII, PII, VII, FeI, CoII and YII.

Table III

Comparison with Normal B Stars

Atomic Species	HD 3473	Normal B Stars Adelman (1984)
HeI	vw	n
CII	pp	n
NII	n	a
OII	n	n
MgI	pp	n
MgII	vs	n
AlII	pp	n
SiII	vs	n
SiIII	s	a
PII	pp	a

Table III (continued)

Atomic Species	HD 3473	Normal B Stars Adelman (1984)
ClII	n	a
CaII	n	n
ScII	ss	n
TiII	s	n
VII	pp	a
CrII	s	n
MnII	n	a
ZeI	pp	n
FeII	s	n
FeIII	s	a
CoII	pp	a
NiII	n	n
SrII	s	n
YII	pp	a
ZrII	s	a
Rare Earths	p	a
HgII	p	a

Table IV

Comparison with Other Peculiar Objects

Atomic Species	HD 3473	HD 213918 M (1981)	Scl J-S(1961)	3 Cen A B(1960)	HR 1100 M(1982)	HD 34452 T.etal(1970)	HD 200311 A(1974)
HeI	vw	w	w	w	w	w	a
CII	pp	n	n-ss	ss	n	n	ss
NII	n	a	n	n	n	n	a
OII	n	w	sw	w	w	a	pp
MgII	vs	n-ss	n-ss	n	n-ss	n	ss
AlII	pp	p	n-ss	a	a	a	pp
SiII	vs	s	ss	n	s	s	s
SiIII	s	ss	n	n	ss	p	p
PII	pp	p	p	p	p	p	a
PIII	a	p	a	p	p	a	a
SII	a	p	n	a	pp	p	p
ClII	n	p	s	a	p	p	p
CaII	n	ss	ss	n	ss	n-sw	ss
ScII	as	pp	s	n-ss	pp	p	pp
TiII	s	ss	s	s	p	p	p
TiIII	a	p	a	a	p	a	w
VII	pp	a	s	s	pp	a	a
CrI	a	pp	a	a	pp	a	a
CrII	s	p	s	s	p	p	p
MnI	a	pp	a	a	pp	a	a
MnII	n	sw	s	a	p	pp	p
FeI	pp	p	a	a	p	a	p
FeII	s	s	s	ss	ss	p	p
FeIII	s	s	p	a	p	a	p
CoII	pp	a	a	a	pp	a	p

Table IV (continued)

Atomic Species	HD 3473	HD 213918 M (1981)	Scl J-S(1961)	3 Cen A B(1960)	HR 1100 M(1982)	HD 34452 T.etal(1970)	HD 200311 A(1974)
NiII	n	a	a	a	pp	p	p
NiIII	a	a	a	a	p	a	pp
GaII	a	pp	a	p	p	a	p
SrII	s	s	s	a	ss	p	ss
YII	pp	a	a	a	p	a	p
YIII	a	a	a	a	p	a	pp
ZrII	s	pp	a	a	p	a	pp
CdII	a	a	a	a	pp	a	a
CsII	a	pp	a	a	a	a	a
Rare Earths	p	p	a	a	p	a	p
PtII	a	a	a	a	p	a	p
HgII	p	p	a	a	p	a	

Symbols and Remarks to Tables III and IV

M(1981)	Malaroda (1981)
M(1982)	Malaroda (1982)
J-S(1961)	Jugaku and Sargent (1961)
B(1960)	Bidelman (1960)
T. et al.(1970)	Tomley, Wallerstein and Wolff (1970)
A(1974)	Adelman (1974)
vw:	very weak
w:	weak
n:	normal
s:	strong
ss:	slightly strong
vs:	very strong
a:	absent
p:	present
pp:	possibly present

III. COMPARISON WITH NORMAL B STARS.

In Table III we present a comparison of HD 3473 with a group of B normal stars studied by Adelman (1984).

From the table we deduce the following differences between HD 3473 and the normal B Stars:

1) He is weaker in HD 3473, Mg and Si are strongly reforzed.
2) The presence in HD 3473 of Cl II, Mn II, Fe III, Zr II, Rare Earths and Hg II, all of them absent in the normal B stars.

IV. COMPARISON WITH OTHER PECULIAR OBJECTS

Table IV shows a comparison of the elements present in the spectrum of HD 3473 with the behaviour of those present in the spectra of other peculiar objects: namely, HD 213918, α Sculptoris, 3 Centaurus A, HR 1100, all of them classified as He-weak stars; and HD 34452 and HD 200311, two Si stars.

The most important differences with the group of He-weak stars are:

1) the greater intensity of Mg II and Si II in HD 3473.
2) the probable absence of P II, S II (not seen also in 3 Cen A) and Ga II, which is not present in α Scl also.
3) the definite presence of Zr II in HD 3473, which is only identified in HR 1100, but other elements present in this star, as P III, Ni III, Y III and Pt II are not seen in HD 3473.
4) Rare Earths are not seen in some stars of the group.

The differences with the Si stars HD 34452 and HD 200311 are concerned mainly with S II, which is present in both stars; Fe III, Zr II and the Rare Earths are absent in

HD 34452 but present in HD 3473 and HD 200311; Ga II, Y II and Pt II are present in HD 200311 but not in HD 3473 and HD 34452.

We can finally say that HD 3473 shares the principal characteristics of the He- weak stars and the Si stars (groups CP2 and CP4 of Preston's classification): Helium lines weakened and Si II and Si III enhanced.

We have undertaken a detailed abundance determination in view of obtain a more clear picture of this object.

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